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A non-pulsating neutron star in the supernova remnant HESS J1731-347/G353.6-0.7 with a carbon atmosphere

Klochkov D., Pühlhofer G., Suleimanov V., Simon S., Werner K., Santangelo A.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Context. The central compact object (CCO) candidate in the center of the supernova remnant shell HESS J1731-347/G353.6-0.7 shows no pulsations and exhibits a blackbody-like X-ray spectrum. If the absence of pulsations is interpreted as evidence for the emitting surface area being the entire neutron star surface, the assumption of the measured flux being due to a blackbody emission translates into a source distance that is inconsistent with current estimates of the remnant's distance. Aims. With the best available observational data, we extended the pulse period search down to a sub-millisecond time scale and used a carbon atmosphere model to describe the X-ray spectrum of the CCO and to estimate geometrical parameters of the neutron star. Methods. To search for pulsations we used data of an observation of the source with XMM-Newton performed in timing mode. For the spectral analysis, we used earlier XMM-Newton observations performed in imaging mode, which permits a more accurate treatment of the background. The carbon atmosphere models used to fit the CCO spectrum are computed assuming hydrostatic and radiative equilibria and take into account pressure ionization and the presence of spectral lines. Results. Our timing analysis did not reveal any pulsations with a pulsed fraction above ~8% down to 0.2 ms. This finding further supports the hypothesis that the emitting surface area is the entire neutron star surface. The carbon atmosphere model provides a good fit to the CCO spectrum and leads to a normalization consistent with the available distance estimates of the remnant. The derived constraints on the mass and radius of the source are consistent with reasonable values of the neutron star mass and radius. After the CCO in Cas A, the CCO in HESS J1731-347/G353.6-0.7 is the second object of this class for which a carbon atmosphere model provides a consistent description of X-ray emission. © ESO, 2013.

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Keywords

ISM: supernova remnants, Stars: atmospheres, Stars: neutron